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SOME COMMON MICROSTRUCTURAL FEATURES OF NICKEL-IRON METEORITES AND CAST FERROUS ALLOYS

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Certain cast irons and several nickel-iron meteorites share common microstructural features. Most prominent are carbon compounds such as graphite nodules and compacted/vermicular graphite. Examples of the morphologies for the graphite phase can be seen in nickel-iron meteorites such a Seligman and Wichita County (Buchwald, 1975). Because currently accepted meteorite formation theory considers nickel-iron meteorites to have undergone extensive solid state phase transformations (metamorphism), the similarities with earth-formed cast irons have not been highlighted.

This presentation will compare the microstructural features of earth-formed cast irons and nickel-iron meteorites. Microstructural evidence will be presented to support the contention that the graphite compounds are melt-grown phases not only in cast irons, but also in nickel-iron meteorites. More support comes from recent advances in understanding anomalous eutectic solidification (See “Eutectic Solidification Processing: Crystalline and Glassy Alloys,” by R. Elliott, 1983), which serve to explain the formation of graphite phases in the meteorites.

As metallic castings, the nickel-iron meteorites probably solidified as multi-kilogram masses in space under radiative cooling conditions. The radiative cooling process leads to a shallow, radially symmetric thermal gradient. Formation conditions for such small masses logically occur in microgravity (or free fall).

The significance of this new connection between earth formed cast irons and nickel-iron meteorites is proposed as follows:

1. The nickel-iron meteorites are cast (or igneous) materials which solidified under microgravity conditions. Cooling time was probably on the order of many hours to months, depending on mass, and not over millions of years, as is currently believed.

2. Most microstructural features may be primary crystallization structures formed under non-equilibrium conditions and not the result of solid state phase transformations, as is currently believed.

3. Meteoritic cast irons can be used to understand an to model the solidification of cast irons themselves as well as other alloys for processing in a space environment.

Buchwald, Vagn F., 1975, “Handbook of Iron Meteorites,” Univ. of California Press.